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(54) Title: HEAT-STABLE AND FRACTURABLE SPRAY-DRIED FREE-FLOWING FLAVOR OIL CAPSULES, METHOD OF MAKING AND USING IN FOODS (57) Abstract Heat-stable and fracturable spray-dried free-flowing flavor oil capsules are made by coacervation and used in a wide variety of flavoring foods such as deep fat frying, baking, microwaving, and extrusion applications.		

Heat-Stable and Fracturable Spray-Dried Free-
Flowing Flavor Oil Capsules, Method of Making and
Using in Foods

Related Application

5 This application is related to
Application Serial No. 07/859,934 filed on even
date herewith entitled "Aqueous Liquid Flavor Oil
Capsules, Method of Making and Using in Foods".

Background of the Invention

10 A considerable amount of effort has been
devoted for many years to provide solid particulate
flavoring materials in which a flavor oil is
contained in the particulate matrix. Various
attempts have been made to fix flavor oils in many
15 different types of organic matrices to provide
stable free-flowing powders or particles which
contain the flavor oils for flavor release when
incorporated into many types of foods. Several
principle techniques have been proposed for the

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preparation of solid particulate flavoring materials. These are plating, spray-drying and encapsulation techniques.

5 In a typical spray-drying operation, a flavor oil is coated or agglomerated with a solid particulate material so that the flavor oil is dispersed within the spray-dried particle. Spray-drying involves the use of large quantities of air usually at an elevated temperature of, for example, 10 about 250-450°F to provide a solid coating or flavor matrix surrounding the flavor oil. Conventional spray drying can cause changes to take place in the flavor oil and can also result in sizeable losses of volatile constituents by 15 evaporation. The loss of flavor may adversely affect the final flavor due to the fact that loss of flavoring material may be made up largely of the very low boiling point constituents with the result that the loss of these constituents changes the 20 flavor of the end product.

More recently, as evidenced by European patent application numbers EP 455598 and 401954, flavor oils have been microencapsulated in the form of coacervate microcapsules, which comprise a core 25 of flavor oil and a coating layer around the core. The coating layer is prepared by coacervation which is a process for the aggregation of colloidal

spheres held together by electrostatic forces. In complex coacervation, the aggregation of colloidal spheres is a mixture of two or more oppositely charged hydrophilic colloidal materials of both cationic and anionic type. For instance, the colloidal material may be selected from the group of materials such as gelatin, casein, agar-agar, gum arabic, carboxymethylcellulose and the like and mixtures thereof. Coacervation, or aggregation to uniformly distribute the colloidal materials around the flavor oil droplets, is then carried out. By diluting an emulsion of the flavor oil in the presence of such colloidal materials with water, adjusting the pH of the emulsion, or temperature, or combinations of such techniques.

It has also been proposed in methods of making flavoring materials to form a coacervate from gelatin and gum arabic colloidal materials for the purpose of encapsulating a garlic flavor oil as disclosed in U.S. Patent 3,647,481. According to this patent, the coacervate capsule slurry is stirred and cooled at 5°C, with stirring, for at least 2.5 hours. The slurry is then spray-dried and the capsules thus formed are filtered then mixed with a vegetable soup base. The resulting capsule-soup based mixture is then added to boiling water thereby creating a soup having a flavor with

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garlic seasoning.

While many improvements have been made in the art for making particulate flavoring materials, further improvements are needed. It would be advantageous to have methods for continuously encapsulating flavor oil particles with improved particle size control. It would also be advantageous to have reproducible methods for encapsulation that were adaptable to tonnage production. Further, it would be very desirable in achieving these advantages if improved yields and product quality could also be accomplished. Improved methods of flavoring foods are also desired.

Summary of the Invention

This invention is directed to a method for preparing heat-stable and fracturable spray-dried free-flowing solid microencapsulated flavor oil capsules. Spray-dried flavor capsules produced according to this invention contain as much as 70% up to 95% of flavor oil, and are environmentally protected with a heat-stable polymeric coating. The microencapsulated flavor oil capsules are "fracturable", which means that, upon chewing, they provide uniform and sustained release of flavor oil. Spray-dried capsule size control is achieved according to the method with processes adaptable to tonnage production.

The method of this invention involves microencapsulating discrete droplets of emulsified flavor oil by coacervation in water. During coacervation, a polymeric coating over the discrete droplets is formed to produce microencapsulated flavor capsules. The polymeric coating is then cross-linked by covalent or ionic bonding with a cross-linking agent in the water, and the capsules are spray-dried at a suitable temperature for the removal of water to produce heat-stable and fracturable free-flowing spray-dried solid flavor capsules.

By employing the method of this

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invention, flavor oils in amounts of up to 95% by weight, within the range of about 50% to 95% by weight, are encapsulated in a polymeric coating material, i.e., at a ratio of about 10:1 to about 5:1 of oil to coating. Usually about 70% to about 95% by weight oil encapsulation is achieved. In another feature of the invention, a drying aid is added to the coacervated emulsion of flavor oil before spray drying. This drying aid has the effect of lubricating the spray-dried particles and provides for uniform distribution of the spray-dried particles.

The heat-stable and fracturable spray-dried flavor oil capsules may be employed in a wide variety of food applications. For instance, in a preferred form these spray-dried flavor capsules are provided with a cross-linked gelatin coating that protects the flavor oil in a wide variety of food applications involving cooking and food preparation. "Heat-stable" as that term is used herein means protected against the deteriorating effects of heat in microwave, baking, frying and other cooking or heating applications where temperatures are achieved over a range of about 140°F to about 450°F. The heat-stable and fracturable spray-dried flavor capsules are particularly suited for use in deep fat frying of

food where the food product containing the spray-dried flavor capsules is simply submerged in hot oil at about 250° to about 450°F for the required cooking time and the flavor oil is environmentally
5 protected during cooking so that it may be fractured upon chewing the cooked food to provide a sustained and uniform flavor oil release. Microwaveable foods may be also be prepared from a dry or wet mix of ingredients incorporating the
10 spray-dried flavor oil capsules for the preservation of the flavor upon microwave heating or cooking at about 140° to about 212°F and for fracturable sustained flavor release upon chewing the prepared food. Baked foods prepared from
15 flour-based food products having spray-dried flavor capsules incorporated therein may be prepared by cooking at about 170° to about 425°F and the advantages of the fracturable spray-dried flavor oil capsules may similarly be achieved. Extruded
20 food products made from homogeneous mixtures of ingredients may be prepared or cooked. Candies, chewing gums, and other ingestible compositions may be prepared utilizing the spray-dried flavor capsules that are fracturable upon chewing to
25 provide a high flavor burst over sustained periods.

The objectives of this invention, its advantages and features will be further understood

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with reference to the following detailed description and specific examples to enable one with ordinary skill in the art to practice the invention.

5 Detailed Description of the Invention

 A variety of flavor oils may be encapsulated by coacervation and spray-dried to form the heat-stable and fracturable spray-dried flavor capsules. These flavor oils include

10 flavoring aromatic compounds and/or oils, oleoresins and extracts derived from plants, leaves, flowers, fruits and so forth, and combinations thereof. Flavor oils include cinnamon oil, oil of winter green, peppermint oil, bay oil,

15 thyme oil, spearmint oil, cassia oil, and the like. Artificial, natural and synthetic fruit flavors such as vanilla, and citrus oils including lemon, orange, grapefruit, lime, and fruit essences including apple, pear, peach, strawberry, cherry,

20 and so forth, may be used. These flavoring oils may be used individually or in a mixture as is well known in the art. Further examples of such flavoring oils or flavoring agents of this type may be obtained with reference to the above cited

25 patents, and they are incorporated into this description by reference.

 The coating layer, as prepared by

coacervation, comprises one or more colloidal materials which must be hydrophilic, gellable and ionizable. Colloidal materials may be selected from the group consisting of gelatin, alginates, casein, gum arabic, carboxymethylcellulose, and the like and mixtures thereof. In a most preferred form, the colloidal material in the coating layer comprises gelatin.

The method of the invention is practiced usually by first forming a solution of a first colloidal material such as gelatin in water above its gelation temperature. Separately, a second colloidal material such as sodium carboxymethylcellulose is added to water to form a clear solution. The two solutions are then mixed and the temperature is reduced whereupon the flavor oil is mixed into the resulting solution and at a mixing speed to form the desired emulsion. Coacervation, or aggregation to uniformly distribute the colloidal materials around the flavoring oil droplets, is then carried out by diluting the emulsion with water, or adjusting the pH and allowing an elapsed time for the colloid to coat the oil droplets. Then, it is necessary to cross-link the colloidal coating on the emulsified oil droplets and, in a preferred form, glutaraldehyde is used to cross-link the gelatin

coating surrounding the flavor oil droplets. Alum
may also be used to cross-link coated flavor oil
capsules, as typically sized up to about 600
microns, normally in a range of about 100 to 300
5 microns, may be prepared for spray drying.

As indicated above, it is preferred to
add a drying aid to the slurry of coated
microcapsules in aqueous medium prior to spray
drying. Silicon dioxide is a preferred drying
10 agent having a particle size of less than 400 mesh,
but the fineness of the drying agent is not
critical. The coated flavor capsules are now ready
for spray drying and this may be accomplished by
employing a spray drying tower fitted with an air
15 atomization nozzle for spraying counter-current to
the heated air flow. The coated flavor capsules
are delivered to the spray nozzle by a pump at a
suitable rate per hour. Atomization may be
achieved in a number of ways. For example, air
20 atomization, spinning disk or airless atomization
may be employed to provide the heat-stable and
fracturable spray-dried free-flowing solid flavor
oil capsules.

DETAILED DESCRIPTION

25 The following examples illustrate the
practice of this invention and its preferred modes.
It will be understood, however, that these examples

are not intended to limit the scope of the invention.

SPRAY DRYING COACERVATE MICROCAPSULES

5 Example 1 - Sprayed-Dried Free-Flowing
Microcapsules of Lemon Oil and Cross-Linked Gelatin
Coating

 Gelatin (90 grams) and water (810 grams)
were combined at 50°C and mixed until a clear
solution was obtained. Sodium
10 carboxymethylcellulose (9 grams) and 441 grams of
50°C water were separately mixed until a clear
solution formed. The two solutions were then
combined and chilled to 36°C. Lemon oil (720
grams) was mixed into the solution until a desired
15 particle size of less than about 150 microns of oil
droplets were formed. Thereafter, 4 liters of
dilution water at 36°C were added to the batch.
The resultant mixture was slowly cooled to 28°C. A
50% aqueous solution of gluteraldehyde (11.25
20 grams) was added to cross-link the gelatin. The
slurry of microcapsules was then stirred for about
eight hours. Thereafter, silicon dioxide, having a
particle size of up to 400 mesh (32 grams), was
mixed into the slurry to act as a drying aid upon
25 spray drying.

 The above slurry of microcapsules was
then spray-dried under the following conditions. A

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20' pilot-scale spray dry tower was fitted with an air atomization nozzle adapted for spraying counter-current to the air flow. The slurry was then delivered to the spray nozzle by a peristaltic pump running at about 18-24 liters per hour. Air atomization pressure was maintained at about 35-45 psig. The dryer was heated with about 310°F of inlet air for about 10 minutes. The slurry was then introduced into the dryer at a rate to maintain an exit air temperature of about 220°F. The resulting dry microcapsules (less than about 5% water by weight) were removed from the air stream with a cyclone air/particle separator and the yield was approximately 600 grams (74%) having about 85% by weight oil in the capsules.

Example 2 - Spray-Dried Free-Flowing Microcapsules of Vegetable Oil and Cross-Linked Gelatin Coating

The procedures of Example 1 were repeated except that vegetable oil was substituted for the lemon oil. After the microcapsules were formed in substantially the same manner, they were spray-dried under essentially the same conditions to produce the spray-dried microcapsules of vegetable oil having a cross-linked gelatin coating. The capsules yield was about 74% by weight having about 85% by weight oil in the capsules.

Example 3 - Spray-Dried Free-Flowing
Microcapsules of Vegetable Oil Containing Garlic
and Cross-Linked Gelatin Coating

5 The procedures of Example 2 were repeated
except that about 50% by weight garlic was
incorporated into the vegetable oil. After
microcapsules of vegetable oil containing garlic
were formed in substantially the same manner, the
slurry of microcapsules was then spray-dried under
10 essentially the same conditions to produce the
spray-dried microcapsules of vegetable oil
containing garlic and having a cross-linked coating
of gelatin. The capsules yield was about 68% by
weight having about 85% by weight oil in the
15 capsules.

EXAMPLES OF FOOD APPLICATIONS FOR FRACTURABLE
SPRAY-DRIED MICROCAPSULES

I. Deep Fat Fried Foods

Example 1 - Whole muscle meats including
5 beef, chicken, fish and seafood are injected with
the heat-stable and fracturable spray-dried flavor
capsules of the above examples by injecting a
solution containing water, salt, phosphate and
about 0.25% to 1% by weight flavor capsules into
10 the meat flesh. Thereafter, the meat is deep fried
at about 325°-400°F for about 30-90 seconds.
During the course of this procedure, the flavor is
environmentally protected from release at the hot
temperatures by the cross-linked gelatin coating,
15 for example. The cross-linked gelatin prevents the
breakdown and release of the flavor. In this
instance, flavor oils such as pepper oil, onion
oil, lemon oil, dill oil, mustard oil, and other
oils or mixtures thereof, may be spray-dried in
20 microcapsules having cross-linked gelatin coatings
for injection as a component of the injectable
solution.

Example 2- Heat-stable and fracturable
spray-dried flavor oil microcapsules of the above
25 examples are mixed into bread dough either as a
solution or as a powder in an amount of about 0.25%
to 1% by weight. The bread dough is then baked and
may be separated into cubes. The cubes are then

deep fat fried at about 375°F for about 30 seconds. In this example, onion oil, garlic oil, orange oil, red pepper or garlic oil, or the like flavor oils, are encapsulated according to the above spray-dried technique into heat-stable and fracturable microcapsules.

Example 3 - Comminuted meat products consisting of approximately 90% meat and about 10% starch/flour base binder having heat-stable and fracturable spray-dried flavor oil microcapsules incorporated therein at about 0.25% to 5% by weight are prepared. These products are then fried at about 350°F for about 60-120 seconds. Flavors that may be incorporated into the spray-dried flavor capsules include those identified in Example 1 above and such oils are protected from the heating environment, deep fat frying oil, and other environmental conditions so that upon chewing the capsules are fracturable to release the encapsulated flavor oil.

Example 4 - Raw dough products, for example, doughnuts and pastries, were prepared by mixing spray-dried flavor capsules into ingredients consisting of approximately 51% flour, 5% sugar, 1% salt, 40% water and 0.5% yeast or 1% chemical leavening agent and fried at about 350-400°F for about 30-120 seconds. In these examples, spray-

dried flavor capsules of fruit flavors such as berry oil, lemon oil, lime oil, and the like, are prepared by the spray-dried flavor encapsulating process of this invention for incorporation into the dough products at levels of about 0.25% to 1% by weight.

Example 5 - Potato sticks from ground potato or potato strips are made by first forming a mash of potato ingredients containing about 1% by weight the spray-dried flavor capsules for frying at about 350°F for about 60 seconds. In this example, the spray-dried flavor capsules may contain a spice or similar flavor oil identified in Example 1 above and other oils in imparting bacon, chili or pepperoni flavors to the ultimate product.

Example 6 - Corn chips, tortillas and pork rinds are made by first forming a mash of ingredients composed of the appropriate flour, salt and water containing about 1% by weight spray-dried flavor capsules for frying at about 350-400°F for about 45-90 seconds. Flavors oils of the type identified in the above examples may be spray-dried for encapsulation into microcapsules and incorporation into the food that would then yield upon chewing the burst of the appropriate flavor(s).

Examples 7-9 - The procedures of examples

1-3 are repeated to provide a food product containing about 1% by weight spray-dried flavor capsules. Then, a liquid batter consisting of approximately 50% flour and 50% water is coated
5 onto the food product to form a coating of the batter. The coated food product was deep fat fried to provide a fried food product with a battered coating. It will be understood that the spray-dried flavor capsules may be incorporated into the
10 batter, rather than in the food product that is coated with the batter, prior to deep fat frying.

Example 10 - Whole or cut pieces of vegetables and fruit are coated with a liquid batter consisting approximately of 50% flour and
15 50% water containing about 1% by weight spray-dried flavored capsules. In this case, vegetables such as mushrooms, zucchini or broccoli may be coated with the batter containing the flavor capsules. Spray-dried flavor capsules containing onion oil,
20 garlic oil, lemon oil or the like, depending upon the desired flavor, may be employed in the batter prior to deep fat frying.

Example 11 - Pieces of cheese may be substituted for the vegetables or fruit of Example
25 10 and the procedure repeated in order to produce fried cheese products having a batter containing the spray-dried flavor capsules.

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Examples 12-15 - Potato strips or onion rings may be substituted for the vegetables or fruit in Example 10 and battered in a similar fashion with coating on the outside of the strips or onion rings to incorporate the fracturable spray-dried flavor capsules containing onion, pepper, garlic, or other flavoring oils prior to deep fat frying.

Example 14 - In addition to coating any of the above food products with a batter, a breading may be subsequently coated on the outside of the battered food product. The breading may be composed of, but no limited to, dried ground bread, bread crumbs, corn flour, corn grits, corn flakes, rice crumbs, dried pasta, cracker meal, dried potato meal, and blends of such breading.

Example 15 - In addition to forming a batter coating, a casing may be employed instead where, for instance, a hot dog may be encased with a dough consisting of approximately 50% flour, 6% sugar, 1% salt, 2% dry milk, 40% water and 1% yeast. The spray-dried flavor capsules may be incorporated into the encased food or the casing at a suitable level prior to deep fat frying in manner similar to the above examples.

The above Examples 1-15, demonstrate the incorporation of heat-stable fracturable spray-

dried free-flowing flavor capsules that will
release upon chewing the flavor oil that has been
encapsulated. Furthermore, the fracturable spray-
dried flavor capsules are environmentally protected
5 during deep fat frying from the temperatures on the
order of about 325-400°F that have been used. The
flavor oil is protected by such encapsulation from
deterioration or volatilization. The gelatin or
polymeric coating acts as a protective barrier
10 until the flavor is released by fracture upon
chewing. In these examples, gelatin that has been
cross-linked by gluteraldehyde serves as an edible
polymeric coating for microencapsulating the spray-
dried flavor.

for incorporation in a dry mix and microwave cooking. During microwave cooking of the rehydrated dry mix in the formation of brownies or sweet breads, the flavor oil is protected against loss by microwave cooking.

Example 18 - A dry mix for biscuits/scones is formulated by mixing 54% flour, 24% shortening, 22% milk and 1% emulsifier. Spray-dried flavor capsules are incorporated into the dry mix at about 1% by weight to provide flavor oil capsules and dry mix for rehydration by the customer and microwave cooking. The spray-dried flavor microcapsules are prepared as described above. For instance, fruit, cinnamon or other flavor oils may be encapsulated in fracturable spray-dried particles for incorporation in a dry mix and microwave cooking. During microwave cooking of the rehydrated dry mix in the formation of biscuits/scones, the flavor is protected against loss by microwave cooking.

Example 19 - A dry mix for bread is formulated by mixing 51% flour, 6% sugar, 1% salt, 1% yeast and 1% emulsifier for addition to 40% water for rehydration. Spray-dried flavor capsules are incorporated into the dry mix at about 1% by weight to provide a flavored dry mix for rehydration by the customer and microwave cooking.

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The spray-dried flavor microcapsules are prepared as described above. For instance, fruit, cinnamon or other flavor oils may be encapsulated in fracturable spray-dried particles for incorporation in a dry mix and microwave cooking. During microwave cooking of the rehydrated dry mix in the formation of bread, the flavor oil is protected against loss by microwave cooking.

Example 20 - A dry mix for cookies or cakes is formulated by mixing 43% flour, 25% brown sugar, 20% shortening, 9% egg, 1% water, 0.3% salt, and 0.7% baking soda. Spray-dried flavor capsules were incorporated into the dry mix at about 1% by weight to provide a flavored dry mix for rehydration by the customer and microwave cooking. The spray-dried flavor microcapsules are prepared as described above. For instance, fruit, lemon or other flavor oils may be encapsulated in fracturable spray-dried particles for incorporation in a dry mix and microwave cooking. During microwave cooking of the rehydrated dry mix in the formation of cookies or cakes, the flavor oil is protected against loss by microwave cooking.

Example 21 - A sauce may be prepared where the spray-dried flavor capsules have been incorporated as prepared in accordance with the above procedures. For instance, a white sauce may

be prepared containing the fracturable spray-dried
flavor oil microcapsules containing pepper oil,
onion oil, lemon oil, dill oil, garlic oil, or the
like, that then would be added as a part of a final
5 product.

Example 22 - Microwaveable popcorn
kernels containing flavor are prepared by adding
fat or oil, kernels and the spray-dried flavor
capsules into a typical microwaveable bag. In this
10 case, the flavor may include a chili oil, tallow
flavor or the like, depending upon the desired
flavor in heat-stable spray-dried fracturable
capsule form. The kernels may be popped in a
microwave at full power for an appropriate period
15 of time, normally approximately 3 minutes. During
microwaving, the flavor is protected against
deterioration or loss.

Example 23 - Any of the above whole
muscle meats such as beef, chicken, fish and
20 seafood that are flavored by injection in Example 1
above, may form the basis for a prepared meal,
casserole, stew and other microwaveable dishes
where the spray-dried flavor capsules are
incorporated into the product. The food product
25 would either be cooked or prepared for reheating in
the microwave.

Example 24 - Oatmeal/farina may be

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combined with spray-dried flavor capsules for
heating in the microwave and cooking for
approximately two minutes in order to provide a
flavored oatmeal/farina upon chewing where the
5 flavor was environmentally protected during
microwaving.

III. Baked Foods

Example 25 - A chemically leavened or yeast leavened bread is formulated containing approximately 50% flour, 6% sugar, 1% salt, 40% water and 1% yeast or a chemical leavening agent. In this example, spray-dried flavor capsules are incorporated at about 1% by weight into the dough. Such spray-dried flavor capsules are prepared in accordance with the above examples and may be exemplified by those set forth in Example 2 above. During fermentation and subsequent baking for about 20-60 minutes at about 325-370°F, the flavor oil is protected against baking temperatures and the surrounding environment.

Example 26 - Cookies were formulated containing approximately 50% flour, 23% shortening, 16% sugar, 5% water, 5% egg, 0.25% salt and 0.12% soda. In this example, spray-dried flavor capsules are incorporated at about 1% by weight into the dough. Such spray-dried flavor capsules are prepared in accordance with the above examples and may be exemplified by those set forth in Example 2 above. During subsequent baking for about 10-20 minutes at about 325-370°F, the flavor oil is protected against baking temperatures and the surrounding environment.

Example 27 - Crackers/baked snacks were

formulated containing approximately 64% flour,
24.6% water, 7.5% shortening, 2.5% sugar, and 0.6%
salt. In this example, a spray-dried flavor
capsules are incorporated at about 1% by weight
5 into the dough. Such spray-dried flavor capsules
are prepared in accordance with the above examples
and may be exemplified by those set forth in
Example 2 above. During fermentation and
subsequent baking for about 8-15 minutes at about
10 400-450°F, the flavor oil is protected against
baking temperatures and the surrounding
environment.

Example 28 - Cakes were formulated
containing approximately 40% flour, 2% baking
15 powder, 1% salt, 47% sugar, and 10% shortening. In
this example, spray-dried flavor capsules are
incorporated at about 1% by weight into the dough.
Such spray-dried flavor capsules are prepared in
accordance with the above examples and may be
20 exemplified by those set forth in Example 2 above.
During fermentation and subsequent baking for about
25-35 minutes at about 350°F, the flavor oil is
protected against baking temperatures and the
surrounding environment.

25 Example 29 - Tortillas were formulated
containing approximately 50% flour, 40% water, 6%
sugar, 1% salt and 1% yeast. In this example,

spray-dried flavor capsules are incorporated at about 1% by weight into the dough. Such spray-dried flavor capsules are prepared in accordance with the above examples and may be exemplified by those set forth in Example 2 above. During fermentation and subsequent baking for about 8-10 minutes at about 350-400°F, the flavor oil is protected against baking temperatures and the surrounding environment.

Example 30 - Pie shells were formulated containing approximately 56.2% flour, 25% shortening, 16% water, 1% salt, 1% dextrose, 0.2% calcium carbonate and 0.1% soda. In this example, spray-dried flavor capsules are incorporated at about 1% by weight into the dough. Such spray-dried flavor oil capsules are prepared in accordance with the above examples and may be exemplified by those set forth in Example 2 above. During fermentation and subsequent baking for about 8-12 minutes at about 325-400°F, the flavor oil is protected against baking temperatures and the surrounding environment.

Example 31 - Frostings were formulated containing approximately 76% powdered sugar, 6% milk, 2% cream, 10% shortening and 5% egg white. In this example, spray-dried flavor capsules are incorporated into the frosting at a suitable level.

Such spray-dried flavor oil capsules are prepared in accordance with the above examples and may be exemplified by those set forth in Example 2 above. In this case, after mixing, no cooking is needed because it may be served as a frosting.

Example 32 - Fruit fillings were formulated containing approximately 30% fruit puree, 20-30% water, 10-35% corn syrup, 3-10% sugar and 2-6% stabilizer. In this example, spray-dried flavor oil capsules are incorporated at about 1% by weight into the mixture. Such spray-dried flavor oil capsules are prepared in accordance with the above examples and may be exemplified by those set forth in Example 2 above. During fermentation and subsequent baking for about 10-30 minutes at about 165-190°F, the flavor oil is protected against baking temperatures and the surrounding environment.

Example 33 - Pressed snacks or rice cakes may be prepared where grain would be pressed or bound together through adherence of a starch solution or water spray containing a suitable amount of spray-dried flavor oil capsules prepared in accordance with the above procedures. Any of the flavors exemplified by onion, garlic, orange, pepper, lemon, mustard or other oils may be employed as the flavor oil in the spray-dried microcapsule.

IV. Extruded Food Products

Example 34 - A cereal or a snack-like product is produced by mixing about 10-95% flour, about 5-15% water, 1-90% starch, about 1% salt, about 10% sugar and 0.5% calcium carbonate. The ingredients were formed into a homogeneous mass that may be extruded into any one of a number of food forms and cooked either simultaneously during extrusion or thereafter. Spray-dried flavor oil capsules produced in accordance with the preceding examples and providing any one of a number of the above stated flavors such as onion, garlic, pepper oil, lemon oil, and so forth, may be mixed together in amounts of from about 0.25% to 5% by weight with the above ingredients in order to environmentally protect the flavor oil and provide a fracturable capsule whereby the burst of flavor may be achieved upon mastication.

Example 35 - The procedure according to Example 34 is repeated except that the formula for the extrudable food product is modified to provide a beef leather or jerky composition including proteins that have been cooked out, shredded, and extruded. The spray-dried flavor oil capsules are again incorporated into the ingredients of the mass prior to extrusion and/or cooking to achieve the fracturable flavor oil capsules in the food product

and the benefits of this invention.

Example 36 - A dough consisting of about 60-80% flour, 0-10% eggs, 0-20% water and about 1% salt was prepared by mixing these ingredients with a suitable amount of spray-dried flavor particles produced in accordance with the above examples. Upon formation into a homogeneous mass, followed by extrusion, noodles may be prepared containing the fracturable flavor oil capsules.

Example 37 - A fruit leather or similar product is prepared by combining as dry ingredients 34% high fructose corn syrup, 29% sugar, 11% water or fruit puree, 7-15% starch, 2% emulsifier, 1% citric acid and 2% vegetable oil. The spray-dried flavor oil capsules are incorporated into the ingredients in a suitable amount to accentuate the fruity flavor. A fruit flavor oil may be encapsulated according to the above technique by coacervation and spray-dried to produce the fracturable flavor oil capsules. The ingredients are formed into a homogeneous mass, extruded and cooked for about 1-3 minutes at about 200-212°F.

Example 38 - A licorice product was made by combining about 45.7% flour, about 7.7% starch, about 13% water, about 19% cake flour, about 8% sugar, about 2% emulsifier, about 2% oil, about 0.3% salt and about 1% citric acid. Spray-dried

flavor oil capsules containing flavor oils such as
cherry, orange, lemon or the like were incorporated
in with the other ingredients in a suitable amount
and environmentally protected during extrusion and
5 cooking for about 6-10 minutes at about 180-212°F.

V. Miscellaneous Food Products

Example 39 - A candy product was prepared by combining about 51% sugar, 45% corn syrup and about 4% water with about 1-5% spray-dried flavor oil capsules prepared in accordance with the above techniques containing orange oil, lemon oil, lime oil or other fruity oils, for example. After combination of the ingredients, the product is cooked in a pan at about 280-285°F for about 1-5 minutes to provide a candy product.

Example 40 - A food product having the perception of fat with a low fat or fatty oil dose is made by providing spray-dried capsules containing vegetable oil in accordance with the above-described techniques to provide a fracturable fatty oil capsule that may be coated onto a food product or incorporated into the food product in accordance with the techniques described in Examples 1-15, for example. In these examples, a low dose of fat in such finely divided form as contained in the fracturable capsules, upon chewing, will be released imparting the perception of a high fat content when deposited on the teeth, tongue and taste buds.

Example 41 - A chewing gum is prepared by providing a typical gum base containing gum, starch and/or protein and a suitable amount of the spray-

dried flavor oil capsules of the above examples.
The capsules protect the flavor oil from molecular
inclusion in the macromolecular structure of the
gum during processing. The flavor is thus
5 encapsulated and will not be absorbed in the gum
matrix such that when fractured upon chewing, a
sustained burst of flavor oil will be released.

In view of the above detailed
description, other variations will become apparent
10 to a person of ordinary skill in the art and such
are within the scope of this invention.

We claim:

1. A method for preparing heat-stable and
fracturable spray-dried free-flowing solid flavor oil
capsules comprising

forming an emulsion of discrete flavor oil
5 droplets in water,

forming a polymeric coating over the
discrete flavor oil droplets by coacervation to
produce flavor oil capsules in the water,

cross-linking said polymeric coating on the
10 capsules in the water,

spray drying said polymer coated flavor oil
capsules to remove the water and provide heat-stable
and spray-dried free-flowing solid flavor oil
capsules, said capsules fracturable upon chewing to
15 provide a uniform and sustained flavor oil release.

2. The method of claim 1 conducted to provide microencapsulated flavor oil capsules each having about 70-95% by weight oil.

3. The method of claim 1 comprising the further step before spray drying of adding a drying aid to the water after cross-linking said polymer coating on the capsules.

4. The method of claim 3 wherein said drying aid is finely divided silicon dioxide.

5. The method of claim 1 wherein the ratio of the flavor oil to the polymeric coating is about 10:1 to about 5:1.

6. The method of claim 1 wherein the flavor oil capsules are sized up to about 600 microns.

7. The method of claim 1 wherein the polymer coating is selected from the group consisting of gelatin, carboxymethylcellulose, gum arabic, casein and alginate, and mixtures thereof.

8. The method of claim 1 wherein said polymeric coating is gelatin and cross-linking with glutaraldehyde or alum.

9. A method of flavoring foods comprising incorporating heat-stable and fracturable spray-dried flavor oil capsules of claim 1 into a food in an effective flavor amount, said capsules protecting said flavor oil in said food and fracturable upon chewing said food to provide a uniform and sustained flavor oil release.

10. The method of claim 15 wherein said food is selected from the group consisting of beef, chicken, fish and seafood and

cooking said food by heating, said spray-dried flavor oil capsules protecting said flavor oil in said cooked food and fracturable upon chewing said cooked food to provide a uniform and sustained flavor oil release.

11. The method of claim 10 comprising injecting said flavor oil capsules into the food prior to cooking.

12. The method of claim 9 wherein said food is a flour-based food product and

cooking said food by heating, said spray-dried flavor oil capsules protecting said flavor oil in said cooked food and fracturable upon chewing said cooked food to provide a uniform and sustained flavor oil release.

13. The method of claim 12 comprising cooking by frying the food in hot oil.

14. The method of claim 12 comprising cooking by baking.

5 15. The method of claim 9 comprising incorporating said spray-dried flavor oil capsules into the food by coating the food with said capsules.

10 16. The method of claim 9 comprising the further step of cooking said food by heating, said spray-dried flavor oil capsules protecting said flavor oil in said cooked food and fracturable upon chewing said cooked food to provide a uniform and sustained flavor oil release.

15 17. The method of claim 16 comprising cooking by frying the food in hot oil.

18. The method of claim 16 wherein said food is selected from the group consisting of meat, vegetable, fruit, cheese, potato, and flour-based food product.

20 19. The method of claim 15 comprising said cooking by microwave heating.

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20. The method of claim 19 wherein the food is a flour-based food product and the method includes providing a dry mix of ingredients for said flour-based food product containing said spray-dried flavor oil capsules for rehydration with water before microwave heating.

21. The method of claim 20 wherein said flour-based food product is selected from the group consisting of cake, brownies, bread, biscuit, cookies and pie.

22. The method of claim 19 wherein said food is popcorn kernels containing the spray-dried flavor oil capsules.

23. The method of claim 9 further comprising extrusion of said food containing said spray-dried flavor oil capsules.

24. The method of claim 23 wherein said food is a flour-based food product.

25. The method of claim 24 comprising cooking said flour-based food product.

26. The method of claim 23 comprising cooking the extruded product.

27. The method of claim 9 wherein said food is selected from the group consisting of candy and chewing gum.

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28. The method of claim 9 wherein the spray-dried flavor oil capsules contain a fat or vegetable oil, said capsules fracturable upon chewing of said food to provide a low dose of fat or oil in said food with a high fat or oil dose perception.

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29. The method of claim 28 comprising coating said food with said capsules.